Appendices

Bio in the Region *Pacific Salmon–A Unique Nutrient Cycle*

(This article is written by Gail Hickman Davis, primarily from excerpts of: Pacific Salmon Carcasses: Essential Contributions of Nutrients and Energy for Aquatic and Terrestrial Ecosystems by C. Jeff Cederholm, Matt D. Kunze, Takeshi Murota, and Atuhiro Sibatani; Fisheries, the Journal of the American Fisheries Society, Vol. 24, No. 10, October 1999.)

Pacific salmon and other salmonids (those fish in the genus Oncorhynchus) have evolved several unique adaptations to survive and exploit resources in a wide range of aquatic environments.

The most significant of these adaptations is that the fish spend most of their lives in the ocean and migrate upstream to freshwater to breed. This behavior is called anadromy, hence the salmonids are described as anadromous. They are also semelparous, which means they die after spawning once. Many species have adopted these behaviors, including chinook, chum, pink, sockeye, coho, masu, and amago. Anadromous trout such as cutthroat and steelhead repeatedly spawn (iteroparity) to varying degrees, depending on individual runs.

Since most species of Oncorhynchus are semelparous, a healthy spawning run will produce a large number of carcasses after the fish have spawned. Scientists have long observed that these carcasses play an important role in providing food for terrestrial consumers, as Russian expeditioner V.K. Arseniev observed around 1906 along one of the rivers emptying into the Sea of Japan:

> *For cleaning up these swarms of fish nature sent sanitary officials in the form of bears, pigs, foxes, badgers, raccoon, dogs, crows...and jays. The dead fish were taken by the birds as a rule, while the mammals tried to catch the living ones.*

Pacific salmon have long been considered an important conveyor of significant nutrients from the northern Pacific Ocean back to land. This represents a unique way to move nutrients upstream. This subject has attracted attention from scientists and economists throughout the Pacific Rim. Consider Japan's Edo era (1603-1867), when people believed that a streamside forest could provide fish with numerous benefits such as cover, nutrients, and food. This belief remained in the minds of people living near waterfronts or forests after the Meiji Restoration (1868). When the first forest act of Japan was introduced, at the beginning of the twentieth century, it contained an article ordering conservation of uo-tsuki-rin, literally "fish-attracting forest."

The movement of marine nutrients inland can be considered in the context of the Native American culture in the Pacific Northwest. Many Native American tribes in the Columbia River basin traveled long distances to partake in the catch and consumption of salmon, and in doing so distributed their excrement over this vast watershed and beyond. Some tribes of the upper Columbia were known even to cross the Continental Divide to trade dried fish with tribes of the upper Missouri River basin, thus providing another way to transfer marine-derived nutrients to the surrounding land mass.

Since salmon adults spend long periods feeding in the ocean and generally do not feed once they enter freshwater to spawn, the nutrients they release are almost entirely of marine origin. This process represents a major link among marine, freshwater, and terrestrial ecosystems.

The Research

The fate and utilization of nutrients provided by decomposing salmon carcasses may depend on numerous variables, including species (spawning densities and location in the watershed preferred for spawning), in-stream physical structure (retention of organic debris or otherwise), water flow levels, consumption by aquatic and terrestrial wildlife, and the conditions of the riparian ecosystem such as the amount of light that limits primary productivity.

Most studies show that primary production (production by photosynthesis) in lakes and streams is increased by nutrients released by salmon carcasses. Some studies in Alaska showed that salmon carcasses contributed nitrogen and phosphorus compounds to lakes and their tributaries. This probably enhanced the supply of phytoplankton and zooplankton available for young sockeye salmon.

Another study showed that adult salmon excretion and gamete (eggs and sperm) release prior to death also contributed substantial amounts of nitrogen (approximately 30% of the total) into the ecosystem.

There are three main pathways by which nutrients released from salmon carcasses get into the upstream ecosystem.

a. Primary production–producers are mainly green plants which use light energy from the sun to convert carbon dioxide (absorbed from air or water) and water to the sugar glucose. Oxygen is released as a by-product. This chemical conversion is photosynthesis. Plants are able to manufacture all the complex molecules that make up their bodies from the glucose they produce plus a few additional mineral nutrients. Some of these mineral nutrients come from salmon carcasses. Producers range in diversity from microscopic, single-celled algae to plants and large trees.
b. Microfauna on the streambed gravel–the small animals (some microscopic) that live on and among the gravel eat dissolved bits of the rotting carcasses.
c. Direct consumption of eggs, fry and carcasses

Contributions of marine nutrients from salmon eggs could be significant in many stream systems since an average of only 10%-30% of eggs deposited by a female will survive to emerge as fry. Many birds, fish, aquatic insects, and mammals will readily consume salmon eggs.

Eagle numbers decrease when there are high stream flows that wash salmon carcasses away. Many studies have shown a correlation between spawning salmon and where eagles go and how successful eagles are at reproducing.

It has been found that the timing of reproduction in female mink of Chichagof Island, Alaska, shifted to coincide with the availability of salmon carcasses. Annual runs of coho, chinook, and pink salmon provide female mink with unlimited food supplies, which help them meet their nutritional needs during lactation. Spawning salmon provide young animals with an abundance of food, giving them a selective advantage for survival.

Many of the energy requirements for hibernation in some bears are met by consuming salmon carcasses. This is because salmon are more nutrient-dense than virtually any other food source available to bears along the Pacific Northwest coast. Salmon contributed 33%-90% of the metabolized carbon and nitrogen in grizzly bears in the Columbia River basin the Pacific Northwest prior to 1931. Coastal Alaskan brown bears obtain virtually all of their carbon and nitrogen from salmon (85%-100%).

The animals using salmon carcasses within a riparian ecosystem each feed on various parts of the carcass. Twenty-two species of mammals and birds were observed or known to consume salmon carcasses in seven streams of the Olympic Peninsula, Washington. Large carnivores, such as bears or eagles, will first kill live salmon or retrieve carcasses from pools and then carry the carcass to the adjacent bank to be wholly or partially consumed. Smaller animals and scavengers then concentrate on the remainder of the carcass until just bone matter remains. Some small mammals may even use bone material from carcasses deposited on stream banks.

Bears, and other large mammals and birds, can transport carcasses a great distance from streambanks and often will not consume carcasses in the same location. The number of carcasses transported from a stream channel to riparian forest can constitute a large percentage of the stream's total salmon run. It was estimated that 3,611 carcasses, or 63% of an entire run, were moved to a riparian ecosystem by three to eight black bears in a stream in Gwaii Haanas, British Columbia. This allows for random distribution of the salmon-derived nutrients and the decaying carcass, and could have a fertilizing effect on riparian vegetation. Fertilization could occur either through the direct deposition of a carcass or through fecal matter of animals that have consumed carcasses.

Anadromous salmon and their carcasses clearly have significant roles in providing food and nutritional resources to numerous terrestrial animals. The presence and availability of salmon during fall and winter may be of significant importance to many animals since other food sources are limited at that time. Therefore, the ecologically significant connections between anadromous salmon and terrestrial wildlife merits increased attention in fish and wildlife management, ecosystern-based management plans and ecological research.

To ensure effective recycling of nutrients from the ocean back to land, the major vector of this process–wild anadromous salmonids–must recover from its current status. Identifying and securing channels for recycling inorganic nutrients are important components of biological diversity maintenance, at least in the North Pacific. The key to sustaining the human economy also may fie in these material cycles to some degree since our economy relies heavily on healthy ecosystems to sustain food production and other resources. Therefore, the importance of the nutrient feedback system of anadromous Pacific salmon illustrates the need for continued research and corresponding management to protect and recover native salmonid populations before the system collapses entirely.

"Whenever we try to pick out anything by itself, we find it

Glossary

adapted or adaptation: an adaptation is a characteristic that was inherited and cannot be changed in an individual; adaptations have a genetic basis and are passed on to offspring.

adipose fin: small fleshy fin on the back between the tail and the dorsal fin. Removed when the fish is tagged.

alga (-ae plural): a photosynthetic organism which lacks the structures of higher plants, such as roots or seeds; may be single-celled or may be large multicelled organisms such as seaweeds.

alevin: fry that still has the yolk sac attached.

anadromous: fish that live as adults in the ocean, but swim up into rivers and streams to lay their eggs.

angler: a person who fishes.

aquatic: growing, living or frequenting water. In this curriculum aquatic includes both fresh and salt water.

benthos (ic): of or on the bottom of a body of water.

buck: male salmon or trout.

carnivore: animal that eats other living animals which it catches, as opposed to a scavenger which consumes dead animals.

catadromous: animals that live in fresh water and move to the ocean to spawn.

Chinook: one of five species of Pacific salmon; also known as king salmon.

circuli: concentric rings on fish scales; used to tell age of fish.

classification (-ying): a systematic arrangement into groups or categories on the basis of characteristics shared.

cold-blooded: term used to describe animals whose internal temperature is determined by that of its environment; may be quite warm on a hot day; also called ectotherms. Plants function as ectothermic organisms.

consumer: an organism that does not do photosynthesis and must feed on other organisms.

dissolved oxygen: oxygen molecules mixed in solution with water.

ecological balance: the relatively stable conditions found in natural, undisturbed communities over time.

eyed egg: first noticeable stage of egg development.

erode (-sion): gradual wearing away; in this case water is the agent that causes the wearing away.

estuary: region where salt and fresh water mix in a partially enclosed body of water; generally at a river mouth or in lagoons behind barrier beaches.

fertilization: the process of joining egg and sperm.

fingerling: a young fish about the size of a person's finger.

food web (chain): the sequence of organisms in a community which produce food and consume it; the path that food (materials and stored energy) takes through a group of organisms.

fresh water: water with a salinity of less than 0.5 parts per thousand; no taste of salt.

fry: general term for young fish.

fungus: parasitic organism that can appear as a patchy, white growth on the skin.

gills: organs that allow fish to absorb oxygen from water.

green: a fish that is not ready to spawn.

grilse: two-year-old salmon returning to spawn; males are known as jacks, females as jills.

habitat: the arrangement of food, water, shelter, and space suitable to a specific animal's needs. It is the physical and biological environment in which an animal completes its life cycle.

hatchery: a place for spawning fish artificially and raising the young fish.

hen: female salmon or trout.

herbivore: animal that eats plants or algae (photosynthetic organisms).

jack: male grilse.

jill: female grilse.

ladder: a series of steplike waterfalls constructed to allow fish to swim over high barriers (for example, dams and river banks) .

lateral line: row of sensory pores that form a lengthwise line on the side of a fish. It senses water movements and electrical impulses.

migrate: to move periodically or seasonally from one region to another.

migration: movement of animals from one area to another; frequently done on a seasonal basis between specific areas.

milt: sperm.

non-point source pollution: contaminated runoff originating from an indefinite or undefined place, or more often a variety of places

photosynthesis: chemical process that takes place inside cells in which light energy is used to make carbohydrates from carbon dioxide and water; oxygen is a waste product of this reaction; takes place in plants including algae, such as seaweeds and phytoplankton.

phytoplankton: small, generally microscopic aquatic organisms that are photosynthetic and drift with the currents; generally single-celled; includes many kinds of organisms called algae

planting: relocating hatchery fish to a natural environment.

point source pollution: pollution that is released from a specific known source that has an exact location.

predator: animal that hunts and eats other animals.

prey: organism that is eaten by a predator.

producers: organisms that make food; in this curriculum primary producers, generally photosynthetic organisms, are simply called producers.

redd: gravel nest dug by a female salmon for the purpose of laying her eggs.

respiration: chemical process that takes place in the cells of plants and animals in which carbohydrates are broken down and energy is released which can be used by the cells to do work; most common form involves the use of oxygen and the release of the waste products carbon dioxide and water.

ripe: a fish that is ready to spawn.

roe: fish eggs.

salt water: ocean or sea water; salinity of 35 parts per thousand.

skein: membranous packet inside the female in which eggs develop.

smolt: stage of development during which the young fish go through physical changes that prepare them for the transition to salt water.

spawn: the release of eggs for fertilization in the water.

spawning: process of reproduction in fish.

spawning colors: outward color changes on fish noting readiness to spawn.

steelhead: Rainbow trout that migrate to the ocean.

swim bladder: gas filled organ found in most bony fish which is inflated or deflated to adjust the buoyancy of the fish and changes its position in the water.

tagging: marking an individual fish so scientists can tell it from any other.

trolling: the fishing technique of dragging a line through the water behind a slow-moving boat.

turbid: prevents the passage of light; cloudy or opaque.

viscosity: resistance to flow.

weir: artificial barrier that prevents fish from swimming upstream but still allows water to flow downstream.

yolk sac: attached food supply for newly hatched fry.

zooplankton: generally small to microscopic aquatic animals, larvae or eggs that are not strong swimmers and drift with currents; may be a temporary resident of zooplankton or may be a permanent member.

Resources

Salmon Non-fiction Books

Come Back, Salmon: How A Group of Dedicated Kids Adopted Pigeon Creek and Brought It Back to Life. Molly Cone, Sidnee Wheelwright (Illustrator).

Discovering Salmon by Nancy Field, Sally Machlis (Contributor): Workbook and activities, order at: www.heritagehouse.ca/summaries/discoveringsalmon.htm

Field Guide to the Pacific Salmon. Adopt-A-Stream Foundation, Robert Steelquist.

Life Cycle of a Salmon. Angela Royston.

Observing Nature: Salmon. Stephen Savage, Colin Newman (Illustrator).

Pacific Salmon: Alaska's Story. Alaska Department of Fish and Game.

Pacific Salmon: Life Histories. G. Groot, et al.

Reaching Home: Pacific Salmon, Pacific People. Tom Jay (Photographer), and Brad Matsen.

Salmon. John M. Baxter.

Salmon. Sylvia M. James, Paul Bachem (Illustrator).

Salmon Nation : People and Fish at the Edge. Elizabeth Woody (Editor), et al.

Salmon Stream. Carol Reed-Jones.

The Salmon. Sabrina Crewe, Colin Newman (Illustrator). (Explanation of salmon life cycle.)

Salmon Fiction Books

A Salmon for Simon. Betty Waterton, Ann Blades (Illustrator).

Down to the Sea: The Story of a Little Salmon and His Neighborhood. Jay Nicholas (illustrator).

Magic School Bus Goes Upstream : A Book About Salmon Migration. Joanna Cole, Bruce Degen (Illustrator)

Salmon Summer. Bruce McMillan (Illustrator).

Related Non-fiction Books

California Rivers and Streams. Dr. Jeffery Mount.

Creek Critters, A Guide to Common Aquatic Vertebrates and Invertebrates of Central California. This book is a great identification guide. Order from: Livermore Area Recreation & Park District, 71 Trevamo Rd., Livermore, CA 94550. Attn: Ranger Supervisor, phone (925) 373-5770.

First Fish, First People: Salmon Tales of the North Pacific Rim. Judith Roche, Meg McHutchison, editors.

Freshwater Gamerish of North America. Dick Stemberg.

Totem Salmon : Life Lessons from Another Species. Freeman House.

Related Fiction Books

A River Dream. Allen Say.

Devil's Bridge. Cynthia DeFelice.

The Fish Princess. Irene N. Watts, Steve Mennie (Illustrator).

My Father's Boat. Sherry Garland TedRand (Illustrator).

A Swim through the Sea. Kristin Joy Pratt.

Salmon Media

"Cyber Learning Collection": Task Force is a two volume, comprehensive CD-ROM series that investigates salmon ecology and the conflict over salmon restoration at http://www.cyberlearn.com

"Find Your Way": http://www.pbs.org/wgbh/nova/hokkaido/migration.html

The Pacific Salmon and Steelhead Coloring Book U.S. Fish and Wildlife Service. Contact Viola Taylor violataylor@mail.fws.gov

"The Salmon and the Stream" audio tape. Journeys Home. Living River, 16636 74h Ave, NE, Bothel, WA 98011.

"Salmonids in the Classroom," Department of Fisheries and Oceans, British Columbia: http://salmonid.sd73.bc.ca/site.html

"Salmon in the Classroom": www.fish.washington.edu/sic/index.html

"The Salmon Page": www.riverdale.k12.or.us/salmon.htm

Related Media

"Chinook Salmon": http://students.washington.edu/manu19b/UWchinook.html

"eNasco": online catalogue for educational materials at http://www.nascofa.com/prod/Home

"Fly & Field": Trey Combs, author of steelhead books, good local/regional fishing info available at American Fly Fish (Watt & Fair Oaks): http://www.flyfield.com/clipart.htm, http://www.graphsearch.com, www.chartingnature.com

Gyotaku: many sites, ask mamma.com

Glacier Chiller: http://www.glaciercorp.com/index2.html.

"Nature Watch": The ultimate resource for indoor and outdoor educators at 9811 Owensmouth Ave #2, Chatsworth CA 91311, 800/228-5816, 800/229-5814 FAX info@nature-watch.com, www.nature-watch.com

Salmon Videos

Bringing Back the Salmon: Bypassing Dams to Restore Snake River Salmon. National Wildlife Federation 2000. The current threats facing the lower Snake River salmon: how dams kill salmon, recovery methods that, so far, have failed, and explains why dam removal is the best chance these salmon have to survive. 15 minutes.

Journey of the Kings. Northwest Power Planning Council. Depicts the plight of Columbia River Salmon and the regional program designed to protect them. The camera soars over and dives into some of the Northwests most breathtaking environments as it follows the migrating salmon from their freshwater streams to the Pacific Ocean and back again. 26 minutes. 503/230-4171. http://www.bpa.gov/Corporate/KR/ed/page6.htm

Last Chance for the Pacific Salmon. Terra Video 1995. An in-depth look at crises and solutions. 60 minutes. (800) 333-4350.

Life Cycle of the Salmon. Oregon Sea Grant 1999. ORESU-V-99-002. The story of salmons IM cycle with remarkable images that reveal the salmon's world, often from their underwater point of view. A clear, informative narration makes the video suitable for viewers of all ages. 5:30 minutes. (800) 375-9360. http://seagrant.orst.edu/sgpubs/multimedia.html

Nature: Miracle of the Scarlet Salmon. WNET, Time Life Video 1988 #WX052. Award winning film documents the four year life cycle of the gallant and determined sockeye salmon. 60 minutes. (800) 336-1917 ext. 100.

Return of the Salmon: Restoring the Fish to Rivers and Watersheds: Oregon Sea Grant 1995. ORESU-V-95-001. Informative overview of the causes of salmon decline, importance of watersheds in restoration, and actions of watershed groups. 33 minutes. MO 375-9360.

http://seagrant.orst.edu/sgpubs/multimedia.html

Salmon and Steelhead on the Edge. Katherine Domeny Associates 1988. A provocative documentary that traces the decline of California's fisheries and argues recovery is possible. 29 minutes. P.O. Box 2100 Davis, CA 95617-2100.

Salmon Project Video Series. Digital Studios 1996. Teaches students in grades 7-12 to develop critical thinking skills about the preservation and use of natural resources, using the decline of the Pacific salmon as a case study. (800) 499-3322. http// www.cyberlearn.com/

Salmon: Why Bother? Oregon Sea Grant 1999. ORESU-V-99-001. Why do people care that many salmon runs in the Northwest are on the verge of extinction? Six diverse Oregonians give their own views about why they're involved - in various ways - in helping restore salmon and their watersheds. 12 minutes. (800) 375-9360. http:// seagrant.orst.edu/sgpubs/multimedia.html

The Days of Salmon Traps and Pirates. John Sabella & Associates 1995. Tall tales from tire fishing grounds of yesteryear. 30 minutes. (206) 632-6272.

The Great Age of Salmon. John SabeUa & Associates 1994. History of the Northwest and Alaskan salmon industry and the Pacific American Fisheries Company. 30 minutes. (206) 632-6272.

The Magic School Bus Goes Upstream. Scholastic #308 1997. The salmon bus won't stop. Using its sense of taste and smell, it swims the long joumey to a shallow freshwater stream miles away. 30 minutes. TV.

Wild Salmon Forever. Sierra Club, 1996. 22 minutes. (510) 654-7847. http://www.sierraclub.org/store/

Related Videos

Eyewitness: Fish. BBC Wildvision, 1994. Fish guides us on a dazzling voyage of discovery through the waters of the world to investigate the myths and facts about these exotic creatures. 30 minutes. www.amazon.com

Farmers of the Sea. VHS Video. J. R. Larison, L. Weimer, and J. E. Lannan. Oregon Sea Grant, 1984. 57 minutes. (800) 375-9360. https:// admtn.ucsadm.orst.edu/marketplace/web/

In Our Hand. CA Department of Fish and Game, 2003. Video of Nimbus Fish Hatchery. 10 minutes.

Unconquering the Last Frontier. Robert Lundahl and Associates 2000. Documentary film that chronicles the historic saga of the damming and widening of Washington's Elwha River. (415) 543-3155. http://www.evolutionfilm.com

Up the Down Stream. California Department of Water Resources. Feather River Fish Hatchery. 12 minutes. (916) 653-4893.

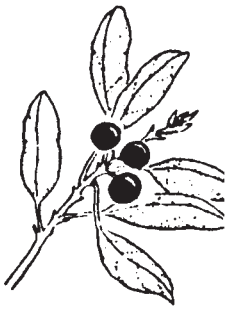
A Visit to the Feather River Hatchery. California Department of Water Resources. A young girl talks to her classmates about her trip to the fish

Common Plants of a Riparian Zone

Riparian vegetation grows adjacent to places where water flows (rivers and streams) or water stands (ponds, lakes and reservoirs). This means riparian areas can be found almost anywhere where there is a year-round source of water. Riparian areas can be recognized by plants that grow there . The scene at the right is a general representation of a riparian area. Shown are some of the more common riparian plants. All of these plants would not necessarily be found together in all riparian areas.

OREGON ASH

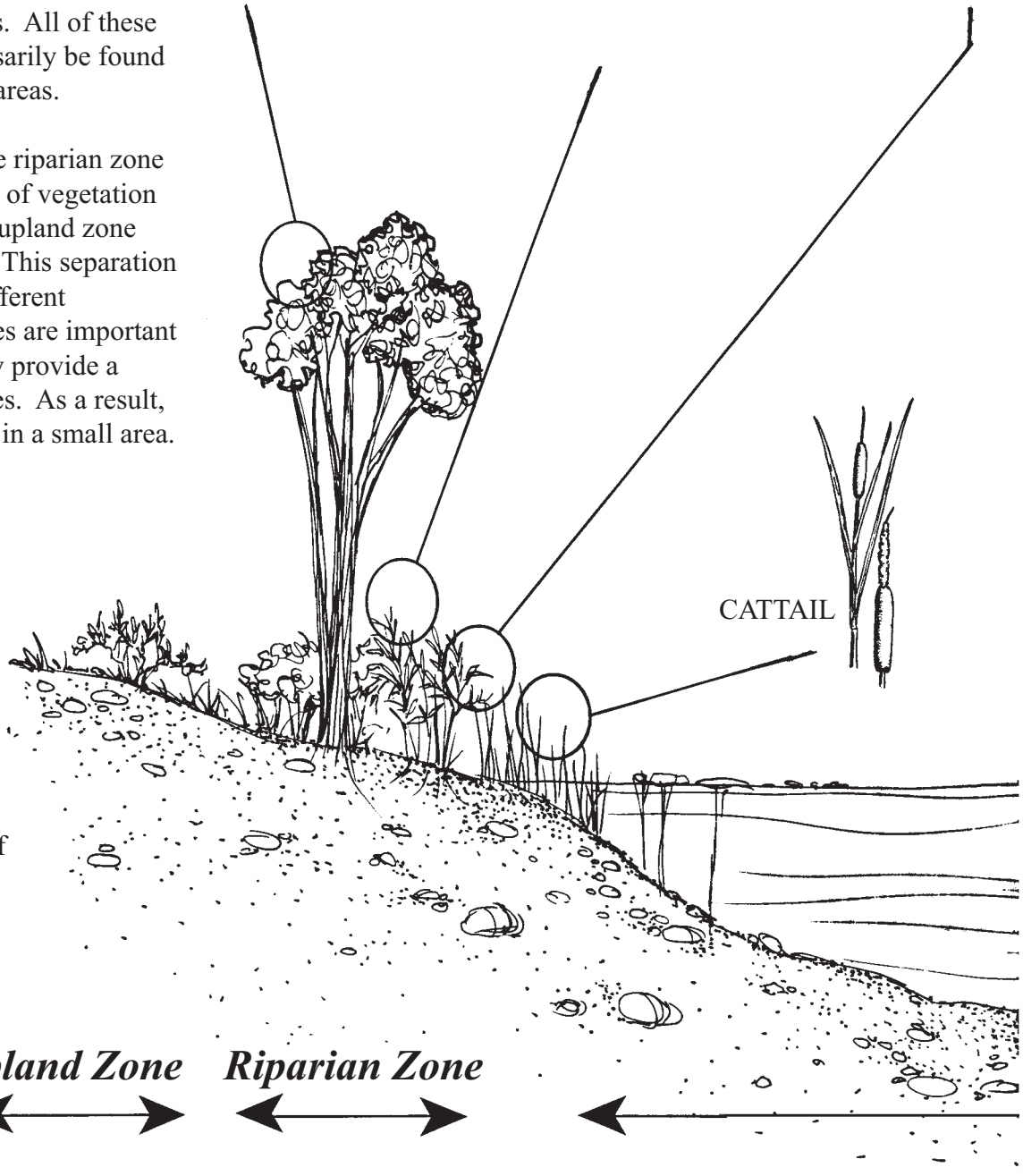
WILLOW

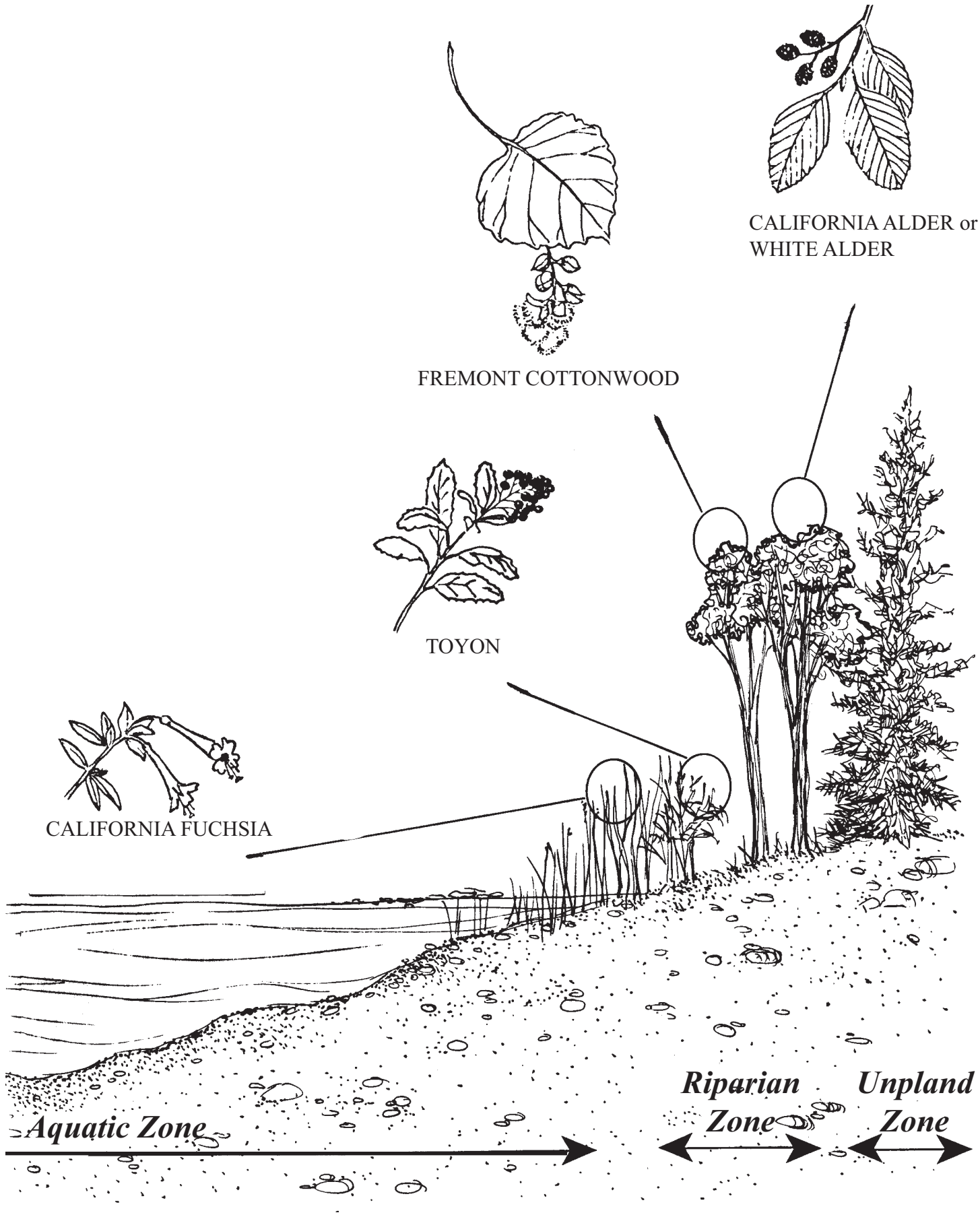


COFFEEBERRY

Viewed from above, the riparian zone is a narrow, dense band of vegetation that separates the drier upland zone from the aquatic zone. This separation creates edges where different ecosystems meet. Edges are important to wildlife because they provide a diversity of habitat types. As a result, more animals can exist in a small area.

Riparian areas also have several different vertical layers; tall cottonwood trees create a canopy over the thick willowshrub level and beneath that are grasses, forbs and cattail. These distinct vertical layers further increase the diversity of habitat types, allowing




CALIFORNIA ALDER or
WHITE ALDER
FREMONT COTTONWOOD
TOYON
CALIFORNIA FUCHSIA
Aquatic Zone
Riparian Zone
Unpland Zone

Where Water Meets the Land...the Riparian Zone

Riparian areas are important places for wildlife. Riparian areas provide animals with food, water and shelter. Riparian areas are important to people, too. They help keep water clean, protect land from erosion and are peaceful places to visit.

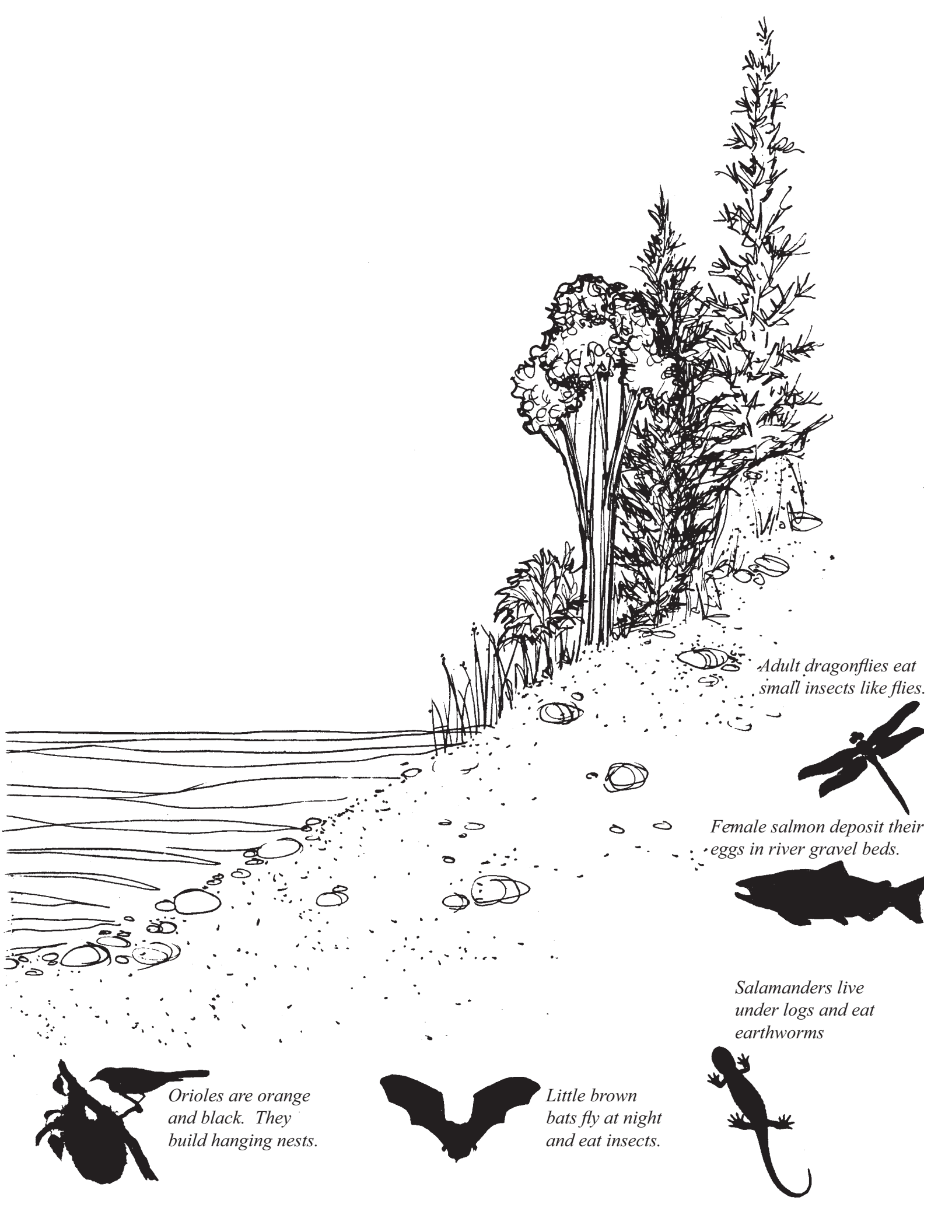
Look at the animals on this page. They need a place to live. Help them find a home. Draw a line from the animal to the place where it may be found.

Kingfishers dive from trees into the water to catch fish.

Garter snakes swim well. They eat frogs and other small animals.

Mayflies can fly as adults. They live underwater as a nymph.

Great blue herons are big wading birds. They catch fish.


Adult dragonflies eat small insects like flies.
Female salmon deposit their eggs in river gravel beds.
Salamanders live under logs and eat earthworms
Orioles are orange and black. They build hanging nests.
Little brown bats fly at night and eat insects.

Grade Level Index

Grade Level
X targeted
0 useful

Activity	Page	Pre-K-2	3-5	6-8
Fishy Facts			X	X
ECE Fishy Facts		X		
Fashion a Fish		0	X	0
Light Vision			X	X
Variations of a Theme			X	X
Finger Fish		X		
The Salmon Story		X	0	
The Great Anadromous Fish Game			0	X
Hooks and Ladders			X	0
ECE Hooks and Ladders		X	0	
Homing Insticts			X	X
Watershed Model			X	0
Home Wet Home			0	X
Erosion			X	0
Stream Planning			0	X
Aquatic Ecosystems			X	
Aquatic Connections		0	0	X
Designing Hatcheries				X
Assess Impact		0	X	X
Legends and Stories			X	0
River Valley Journal			X	X
Salmon Jeopardy			X	X

Student Assessment

Please copy the assessment sheet and have each student answer what they can before you begin activities. **Assure your students that this is not a test.** It is a survey to record their knowledge.

When you finish the salmon units, have students complete the assessment again. Score the assessments (this may be done by students or the instructor) and record the scores on assessment sheets.

Discuss the correct answers with the students. Emphasize how much they learned from the activities. The assessment is a record of the knowledge they have gained.

Return assessment sheets (both pre and post) with any suggestions or comments you have about the Activity Guide. The assessments will help us justify the Sports Fish Restoration Funding Grant that supports this program.

Return pre & post assessments to:

Bobbie Winn
Department of Fish & Game
1416 Ninth Street, Room 117
Sacramento, CA 95814

Answers

K-2

1. 1-Spawners, 2-Egg, 3-Alevins (or sac-fry), 4-Fry, 5-Smolt, 6-Adult (see *Salmon and Steelhead Life Cycle*, Unit 2)
2. (See *Fish Adapted to Life in the Water*, Unit 1)
3. 5
4. Bear, angler, otter, eagle
5. Fry should by in fresh water and adult in ocean.

3-5

1. spawning
2. salmon or salmonid
3. erosion
4. ocean to fresh water
5. oxygen
6. b. watersheds
7. c. dam
8. a.,b.c.d. (all of the choices)
9. A food chain is the sequence of organisms in a community which produce food and consume it. It is the path food takes from plants to animals and shows the transfer of energy from plants to other organisms.
10. The answer should include the six life stages (egg, alevin, fry, smolt, adult and spawner) and that salmon hatch in fresh water, migrate to the ocean and return to fresh water to spawn.

6-8

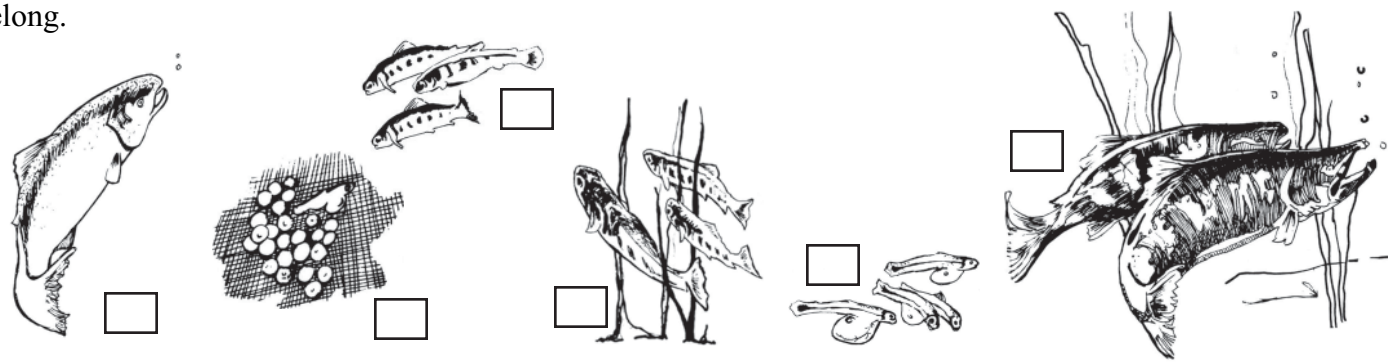
1. spawning
2. salmon or salmonid
3. erosion
4. ocean to fresh water
5. oxygen
6. watershed
7. Answers may include: loss of habitat, dams, removal of gravel, chemicals and pesticides in the water, pumps to remove water, removal of vegetation.
8. Genetic diversity enables an individual organism of adapt to variations or changes in the environment. Hatchery practices: use a large number of spawning pairs, use fish from the entire run, and monitor the number of hatchery fish released to avoid impacting the habitat for wild salmon, use fish from the stream being improved.
9. Food webs are made up of food chains and show how organisms within an ecosystem are interrelated. Food webs represent the transfer of energy from one organism to another, usually as one eats the other and show the transfer of energy from plants to animals. Examples of food webs will vary.
10. Answers will vary but should include the human handling of solid waste, toxic chemicals, water; practices used in agriculture, logging, industry, for recreation, for land development, and the introduction of non-native species.

Grade_____ Number of correct answers_____

Salmon

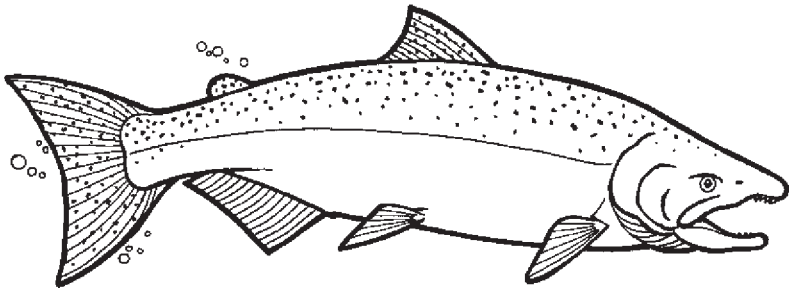
Pre & Post Student Assessment: Kindergarten through 2nd grade

1. Put the life cycle stages in order: Place a number next to each stage to show the order in which they belong.



2. Parts of a fish: Draw a line from the word to the area where it is found on the fish.

Fins (6) **Eyes** **Gill**



Head **Lateral Line** **Mouth** **Nostrils**

3. Fill in the blank: There are _____kinds of Pacific Salmon.

4. Circle the animals that eat salmon.